Docker No.: 04329.3253

OIPE IAP2 APR 1 0 2006 PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF: Shinya Takyu et al.

SERIAL NO: 10/787,207

FILED: February 27, 2004

FOR: SEMICONDUCTOR WAFER DIVIDING METHOD AND APPARATUS

TRANSLATION OF DOCUMENT

COMMISSIONER FOR PATENTS
P.O. BOX 1450
ALEXANDRIA, VA 22313-1450

SIR:

Kenji Kobayashi, a translator residing at 2-46-10, Gokonishi, Matsudo-shi, Chiba-ken, Japan, hereby states:

(1) that I know well both the Japanese and English languages;

(2) that I translated the attached document identified as corresponding to Patent Application No. 2003-054688 filed in Japan on February 28, 2003 from Japanese to English;

(3) that the attached English translation is a true and accurate translation to the best of my knowledge and belief.

DATE: March 28, 2006

BY: Kenji Kobayashi

Kenji Kobayashi

2003-054688

[Name of Document] PATENT APPLICATION

[Reference Number] A000300677

[Filing Date] February 28, 2003

[To] Commissioner, Patent Office

[International Patent Classification] H01L 21/302

[Inventor]

[Address or Residence] 1 Komukaitoshiba-cho, Saiwai-ku, Kawasaki-shi, Kanagawa c/o TOSHIBA MICRO-ELECTRONICS CENTER

[Name] Shinya Takyu

[Inventor]

[Address or Residence] 1 Komukaitoshiba-cho, Saiwai-ku, Kawasaki-shi, Kanagawa c/o TOSHIBA MICRO-ELECTRONICS CENTER

[Name] Ninao Sato

[Applicant for Patent]

[Identification Number] 000003078

[Name] KABUSHIKI KAISHA TOSHIBA

[Agent]

[Identification Number] 100058479

[Patent Attorney]

[Name] Takehiko Suzuye

[Phone Number] 03-3502-3181

[Appointed Agent]

[Identification Number] 100091351

[Patent Attorney]

[Name] Akira Kohno

[Appointed Agent]

[Identification Number] 100088683

[Patent Attorney]

[Name] Makoto Nakamura

[Appointed Agent]

[Identification Number] 100108855

[Patent Attorney]

[Name] Masatoshi Kurata

[Appointed Agent]

[Identification Number] 100084618

[Patent Attorney]

[Name] Sadao Muramatsu

[Appointed Agent]

[Identification Number] 100092196

[Patent Attorney]

[Name] Yoshiro Hashimoto

[Indication of Official Fee]

[Prepayment Register Number] 011567

[Amount of Payment] ¥21,000.-

[List of Items Submitted]

[Name of Item] Specification 1

[Name of Item] Drawings 1

[Name of Item] Abstract 1

[Necessity of Proof] Necessary

[Document] SPECIFICATION

[Title of the Invention] METHOD OF MANUFACTURING SEMICONDUCTOR DEVICE AND APPARATUS FOR MANUFACTURING SEMICONDUCTOR DEVICE

[What is claimed is:]

[Claim 1] A method of manufacturing a semiconductor device characterized by comprising:

a step of forming a semiconductor element in a semiconductor wafer;

a step of performing dicing on the semiconductor wafer along a dicing line; and

a step of irradiating a dicing region of the semiconductor wafer with a laser beam to melt or vaporize a cutting streak formed by dicing.

[Claim 2] The method of manufacturing a semiconductor device according to claim 1, characterized by further comprising, before the dicing step, a step of adhering an adhesive sheet to the semiconductor wafer.

[Claim 3] The method of manufacturing a semiconductor device according to claim 2, characterized in that

the dicing step is a step of fully cutting the semiconductor wafer along the dicing line.

[Claim 4] The method of manufacturing a semiconductor device according to claim 1, characterized in that

the dicing step is a step of forming a groove by performing half-cut dicing on the semiconductor wafer.

[Claim 5] The method of manufacturing a semiconductor device according to claim 4, characterized by further comprising, after the step of irradiating the dicing region

with a laser beam:

a step of adhering an adhesive tape to a semiconductor element formation surface of the semiconductor wafer; and

a step of grinding a backside of the semiconductor element formation surface to at least a depth reaching the groove.

[Claim 6] The method of manufacturing a semiconductor device according to claim 5, characterized by further comprising a step of planarizing a back surface of a semiconductor chip by at least one of wet etching, plasma etching, polishing, buffing, and CMP, after the grinding step.

[Claim 7] The method of manufacturing a semiconductor device according to any one of claims 1 to 6, characterized in that

the step of irradiating the dicing region with a laser beam is performed underwater.

[Claim 8] The method of manufacturing a semiconductor device according to any one of claims 1 to 6, characterized in that

the step of irradiating the dicing region with a laser beam is performed in a vacuum.

[Claim 9] The method of manufacturing a semiconductor device according to any one of claims 1 to 8, characterized in that

the laser beam is one of a YAG-THG laser beam, YVO4 laser beam, and CO_2 laser beam.

[Claim 10] The method of manufacturing a semiconductor device according to any one of claims 1 to 9, characterized in

that

a wavelength of the laser beam is 355 to 1,064 nm.

[Claim 11] The method of manufacturing a semiconductor device according to any one of claims 1 to 10, characterized in that

an output of the laser beam is 0.8 to 4.5 W.

[Claim 12] The method of manufacturing a semiconductor device according to any one of claims 1 to 11, characterized in that

a moving velocity of an irradiation position of the laser beam is 1 to 400 mm/sec.

[Claim 13] An apparatus for manufacturing a semiconductor device characterized by comprising:

a dicer for performing dicing on a semiconductor wafer along a dicing line; and

a laser irradiation apparatus for moving an irradiation position of a laser beam in accordance with a dicing position of the dicer, and melting or vaporizing a cutting streak formed in a dicing region of the semiconductor wafer.

[Claim 14] The apparatus for manufacturing a semiconductor device according to claim 13, characterized by further comprising a sheet adhering apparatus for adhering an adhesive sheet to the semiconductor wafer before dicing of the semiconductor wafer is performed by the dicer.

[Claim 15] The apparatus for manufacturing a semiconductor device according to claim 14, characterized in that

the dicer is used to fully cut the semiconductor wafer.

[Claim 16] The apparatus for manufacturing a semiconductor device according to claim 13, characterized in that

the dicer is used to form a groove by performing half-cut dicing on the semiconductor wafer.

[Claim 17] The method of manufacturing a semiconductor device according to claim 16, characterized by further comprising:

a tape adhering apparatus for adhering an adhesive tape to a semiconductor element formation surface of the semiconductor wafer; and

a grinding apparatus for grinding a backside of the semiconductor element formation surface of the semiconductor wafer to at least a depth reaching the groove formed by the half-cut dicing.

[Claim 18] The apparatus for manufacturing a semiconductor device according to claim 17, characterized by further comprising at least one of a wet etching apparatus or plasma etching apparatus for etching a ground surface of the semiconductor wafer, and a polishing apparatus, buffing apparatus, and CMP apparatus for polishing the ground surface of the semiconductor wafer, after the back surface of the semiconductor wafer is ground by the grinding apparatus.

[Claim 19] The apparatus for manufacturing a semiconductor device according to any one of claims 13 to 18, characterized by further comprising a processing bath for accommodating the semiconductor wafer in water.

[Claim 20] The apparatus for manufacturing

a semiconductor device according to any one of claims 13 to 18, characterized by further comprising a vacuum chamber for accommodating the semiconductor wafer.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a method of manufacturing a semiconductor device and an apparatus for manufacturing a semiconductor device and, more particularly, to a dicing step and dicing apparatus for forming semiconductor chips by dividing a semiconductor wafer.

[0002]

[Prior Art]

Conventionally, a dicing step in the semiconductor device manufacturing process is performed as shown in FIGS. 6(a), 6(b), and 6(c). That is, as shown in FIGS. 6(a) and 6(b), a semiconductor wafer 11 in which elements are already formed is cut in one direction along dicing lines 12-1, 12-2, ⋯, by using a diamond blade (rotating blade) 13. The wafer 11 is then turned by 90° and, as shown in FIG. 6(c), diced again in a direction perpendicular to the former dicing direction. In this manner, the wafer 11 is divided into individual semiconductor chips 14-1, 14-2, 14-3, ⋯.

[0003]

The above dicing step can be performed by either a full-cut method by which the wafer 11 is completely cut, or a half-cut method by which the wafer 11 is diced to about half the thickness of the wafer 11 or to a depth with which the

wafer 11 remains by about 30 μm.

[0004]

The half-cut method requires a dividing operation after dicing; the wafer 11 is sandwiched between flexible films or the like and divided by applying an external force thereto by rollers. When an adhesive sheet is adhered to the wafer 11 before dicing, the wafer 11 is also divided by applying an external force thereto via the sheet by rollers or the like.

[0005]

Each of the resultant chips 14-1, 14-2, 14-3, ···, of the divided wafer 11 is mounted on a lead frame in a die bonding step. At this time, the lower surface of the adhesive sheet is pushed up by a pickup needle for of each of the chips 14-1, 14-2, 14-3, ···, and then the adhesive sheet is penetrated by the needle, thereby bringing the needle into direct contact with the back surface of each chip. Each chip is further raised and removed from the adhesive sheet. The removed chip is conveyed as its upper surface is held by suction by a tool called a collet, and mounted on a die pad of the lead frame.

[0006]

Subsequently, a wire bonding step is performed to electrically connect pads of the chips 14-1, 14-2, 14-3, ···, to inner leads of the lead frame. When the chips are to be mounted on a TAB tape, a heated bonding tool is used to electrically connect pads of these chips to leads of the TAB tape.

[0007]

After that, a packaging step is performed to encapsulate

each chip in a resin or ceramic package, thereby completing a semiconductor device.

[0008]

In the dicing step of the manufacturing method as described above, however, strain or chipping occurs on the side surface of each semiconductor chip owing to cutting streaks, and this lowers the bending strength of the chip. Therefore, if stress is applied thereto which is produced by the pressure applied in the pickup step performed before the step of mounting the chip on the lead frame or TAB tape, or by the difference between the packaging material and chip in thermal expansion characteristics, this stress concentrates on the strain or chipping, so the chip cracks from this strain or chipping.

[0009]

Recently, to incorporate a semiconductor chip in a thin card-like package or the like, a manufacturing method is used by which when a semiconductor wafer is cut, the backside of the pattern formation surface (semiconductor element formation surface) of the wafer is thinned by grinding using a wheel or by polishing using free abrasive grains, and then the wafer is cut by dicing. Also, a technique called DBG (Dicing Before Grinding) is proposed to form thinner chips (see, for example, Pat. Document 1). In this DBG, a cut (half cut) is formed to a predetermined depth from the element formation surface of a wafer, and the back surface of the wafer is ground, thereby dividing the wafer into individual chips and decreasing the thickness at the same time.

[0010]

By this technique, chipping occurring on the back surface or on an edge between the side surface and back surface of a chip can be removed by polishing the back surface of a semiconductor wafer. However, strain or chipping caused by cutting streaks formed on the side surface of a semiconductor chip cannot be removed. The decreasing of the thickness of a chip inevitably lowers the bending strength. Consequently, it is impossible to completely solve the problem that semiconductor chips crack in the assembly steps or in the reliability test before they are packaged, and defective products are formed.

[0011]

In recent years, therefore, instead of dicing using mechanical cutting as described above, a technique is attracting attention in which a semiconductor wafer is cut by laser beam irradiation (see, for example, Pat. Document 2). This cutting method using laser beam irradiation can eliminate streaks or chipping resulting from mechanical cutting. However, a laser beam requires high power, so the side surface of a chip is damaged or roughened by recrystallization after melting. This inevitably lowers the bending strength. Furthermore, when a semiconductor wafer is to be cut via an adhesive sheet, the wafer must be irradiated with a laser beam twice by changing the focusing position (in the direction of depth of the wafer) of the laser beam. This brings about a problem that the dicing step is complicated.

[0012]

[Pat. Document 1]

Jpn. Pat. Appln. KOKAI Publication No. S61-112345

[0013]

[Pat. Document 2]

Jpn. Pat. Appln. KOKAI Publication No. 2001-144037

[0014]

[Objects of the Invention]

As described above, in the conventional semiconductor device manufacturing method and semiconductor device manufacturing apparatus, there has been a problem that strain or chipping occurs on the back surface or the side surface of a semiconductor chip owing to cutting streaks, and this lowers the bending strength of the chip.

[0015]

There has also been a problem that although the cutting streaks occurring on the back surface can be removed by grinding or polishing the back surface of the semiconductor wafer, improvement in bending strength of chip is limited because cutting streaks formed on the side surface of the semiconductor chip cannot be removed.

[0016]

Furthermore, there has been a problem that although the problem resulting from the cutting streaks can be solved by cutting the semiconductor wafer by laser beam irradiation, the laser beam irradiation requires irradiation of a laser beam having high power, and the bending strength is inevitably lowered by damage to the side surface of the chip or roughening

of the side surface thereof.

[0017]

The present invention has been contrived in consideration of these circumstances, and an object thereof is to provide a method of manufacturing a semiconductor device by which bending strength of a semiconductor chip can be prevented from being lowered, and semiconductor chips can be prevented from cracking in assembly steps or in a reliability test.

[0018]

Another object of the present invention is to provide an apparatus for manufacturing a semiconductor device capable of preventing bending strength of a semiconductor chip from being lowered by dicing.

[0019]

[Means for Achieving the Objects]

According to an aspect of the present invention, there is provided a method of manufacturing a semiconductor device comprising: a step of forming a semiconductor element in a semiconductor wafer; a step of performing dicing on the semiconductor wafer along a dicing line; and a step of irradiating a dicing region of the semiconductor wafer with a laser beam to melt or vaporize a cutting streak formed by dicing.

[0020]

According to the manufacturing method described above, dicing region of the semiconductor wafer is irradiated with a laser beam to melt or vaporize a cutting streak formed by dicing, thereby processing the side surface of a chip, after

dicing the semiconductor wafer. Accordingly, strain or chipping caused by cutting streaks formed on the side surface of a semiconductor chip can be removed and the bending strength can be prevented from being lowered. Thus, the semiconductor chips can be prevented from cracking in the assembly steps or in the reliability test.

[0021]

Furthermore, according to another aspect of the present invention, there is provided a apparatus for manufacturing a semiconductor device comprising: a dicer for performing dicing on a semiconductor wafer along a dicing line; and a laser irradiation apparatus for moving an irradiation position of a laser beam in accordance with a dicing position of the dicer, and melting or vaporizing a cutting streak formed in a dicing region of the semiconductor wafer.

[0022]

According to the manufacturing apparatus described above, processing of the side surface of the chip by laser beam irradiation can be successively performed subsequently to the dicing without adjusting the alignment of the dicing region with the irradiation position of the laser beam performed by the dicer. As a result, the bending strength of the chip can be prevented from being lowered without complicating the dicing step.

[0023]

[Embodiments of the Invention]

Embodiments of the present invention will be described below with reference to the accompanying drawings.

[First Embodiment]

FIGS. 1 and 2 are views for explaining a semiconductor device manufacturing method and semiconductor device manufacturing apparatus according to a first embodiment of the present invention. FIG. 1 shows a dicing step, and FIG. 2 shows a step of processing a surface of a dicing region by irradiating the dicing region with a laser beam.

[0024]

First, various semiconductor elements are formed in a semiconductor wafer by a known manufacturing process.

[0025]

Next, a sheet adhering apparatus is used to adhere an adhesive sheet 22 to the backside of the element formation surface of the semiconductor wafer 21 in which the elements are already formed. The adhesive sheet 22 is fixed to a dicing table by suction. The semiconductor wafer 21 is then diced on the major surface side into individual semiconductor chips 25-1, 25-2, 25-3, ···, along a dicing line 24 by using a dicer (e.g., a diamond blade 23).

[0026]

After that, as shown in FIG. 2, a dicing region 26 formed by the diamond blade 22 is irradiated with a laser beam 28 emitted from a laser emitting apparatus 27, thereby melting or vaporizing the chip side surfaces in the dicing region 26. The laser emitting apparatus 27 moves in a direction indicated by the arrow in FIG. 2, and irradiates the dicing region 26 with the laser beam 28.

[0027]

As the laser emitting apparatus 27, it is possible to use, e.g., a YAG-THG laser, YVO4 laser, or CO_2 laser. According to an experiment conducted by using the YAG-THG laser (wavelength 355 nm), with experiment conditions set at a Qsw frequency of 50 KHz, an average output of about 1.5 W, a melting diameter of about 15 μm, and a scanning rate (moving velocity) of 5 mm/sec, it was confirmed that it was possible to melt or vaporize the cut surface and sufficiently remove strain or chipping caused by cutting streaks. In experiments conducted under different conditions, effects were obtained when the wavelength, average output, and scanning rate of the laser beam 28 were 355 to 1,064 nm, 0.8 to 4.5 W, and 1 to 400 mm/sec, respectively. If the laser beam output is small and the scanning rate is high, the cut surface melts and recrystallizes. On the other hand, if the laser beam output is large and the scanning rate is low, the cut surface vaporizes. The surface condition can be optimized by setting the various conditions such as the wavelength, frequency, average output, and scanning rate of the laser beam 28 in accordance with the size, thickness, and the like of the semiconductor wafer or chip.

[0028]

Steps after that are the same as the well-known semiconductor device manufacturing method. That is, a die bonding step is performed to mount each of the chips 25-1, 25-2, 25-3, ⋯, on a lead frame. At this time, the lower surface of the adhesive sheet 22 is pushed up by a pickup needle for each of the chips 25-1, 25-2, 25-3, ⋯, and then the adhesive sheet

22 is penetrated by the needle (the adhesive sheet 22 may not necessarily be penetrated), thereby bringing the needle into direct contact with the back surface of each chip. Then, each chip is further raised and removed from the adhesive sheet 22. The removed chip is conveyed as its upper surface is held by suction by a collet, and mounted on a die pad of the lead frame.

[0029]

Subsequently, a wire bonding step is performed to electrically connect pads of each chip to inner leads of the lead frame. When the chips 23-1, 23-2, 23-3, ⋯, are to be mounted on a TAB tape, a heated bonding tool is used to electrically connect pads of these chips to leads of the TAB tape.

[0030]

After that, a packaging step is performed to encapsulate each chip in a resin or ceramic package, thereby completing a semiconductor device.

[0031]

According to the manufacturing method as described above, the dicing region 26 of the semiconductor chips 25-1, 25-2, 25-3, ⋯, is melted or vaporized as it is irradiated with the laser beam 28. This makes it possible to remove strain or chipping caused by cutting streaks formed on the side surface of each semiconductor chip, and increase the bending strength of the chip. Therefore, it is possible to eliminate defective products resulting from cracking of the semiconductor chips in the assembly steps (the pickup step and resin encapsulation step) or in the reliability test before the semiconductor chips

are packaged.

[0032]

FIG. 3(a) is a microphotograph of the side surface of a semiconductor chip formed by the conventional manufacturing method and manufacturing apparatus. FIG. 3(b) is a microphotograph of the side surface of a semiconductor chip formed by the manufacturing method and manufacturing apparatus of this embodiment. As is apparent from the comparison of FIGS. 3(a) and 3(b), a large number of cutting streaks formed by dicing are present on the side surface of the semiconductor chip formed by the conventional manufacturing method and manufacturing apparatus. By contrast, the side surface of the semiconductor chip whose surface is processed by the laser beam is smooth. Accordingly, stress concentration hardly occurs, and the bending strength of the chip can therefore be increased. Consequently, it is possible to prevent defects such as cracks of semiconductor chips in the pickup step, resin encapsulation step, reliability test, and the like, from occurring.

[0033]

[Second Embodiment]

In the first embodiment described above, description is made by taking the case where the semiconductor wafer 21 is fully cut by dicing as an example. However, the present invention is also applicable to a manufacturing step (DBG) in which grooves are formed by half-cutting the semiconductor wafer 21, and the semiconductor wafer 21 is divided by grinding its back surface.

[0034]

That is, after various semiconductor elements are formed in a semiconductor wafer by known manufacturing steps, the major surface of the semiconductor wafer 21 is diced along a dicing line and chip dividing lines to form half-cut grooves. A diamond blade 23 as shown in, for example, FIG. 1 is used to form these half-cut grooves. The depth of the cut is made larger by about 10 to 30 μm (at least 5 μm) than the final thickness of a chip. This difference is determined by the accuracy of the dicer and grinder.

[0035]

After that, as shown in FIG. 2, a dicing region 26 formed by the diamond blade 22 is irradiated with a laser beam 28 emitted from a laser emitting apparatus 27, thereby melting or vaporizing the chip side surfaces in the dicing region 26. The laser emitting apparatus 27 moves in a direction indicated by the arrow in FIG. 2, and irradiates the dicing region 26 with the laser beam 28.

[0036]

Subsequently, a sheet adhesion apparatus is used to adhere an adhesive sheet (surface protection tape) to the element formation surface of the semiconductor wafer 21 having undergone the half-cut dicing and the surface processing using the laser beam, thereby mounting the semiconductor wafer 21 on a wafer frame. This surface protection tape prevents damage to the elements during the process of grinding and thinning the back surface of the wafer.

[0037]

Then, the back surface of the wafer 21 is ground. In this back surface grinding step, the wafer back surface is ground to a predetermined thickness by rotating a wheel having a whetstone at a high speed of 4,000 to 7,000 rpm. The whetstone is obtained by binding artificial diamond with a resin and molding the resultant material. This back surface grinding step is often performed in a biaxial manner. It is also possible to first roughly grind the surface uniaxially with a whetstone of No. 320 to 600, and then finely grind the surface biaxially with a whetstone of No. 1500 to 2000. A triaxial grinding method can also be used. When grinding reaches the grooves, the semiconductor wafer 21 is divided into individual semiconductor chips 25-1, 25-2, 25-3, …. Even after the semiconductor wafer 21 is thus divided, back surface grinding is continued to obtain a predetermined thickness. As a result, chipping formed in the intersection of the side surface and back surface of each semiconductor chip can be removed.

[0038]

Subsequently, the back surface of each semiconductor chip is planarized by being subjected to mirror polishing performed by, e.g., wet etching using a wet etching apparatus, plasma etching using a plasma etching apparatus, polishing using a polishing apparatus, buffing using a buffing apparatus, or CMP (Chemical Mechanical Polishing) using a CMP apparatus. Since cutting streaks formed by the back surface grinding can be removed by this planarization, the bending strength can

further be increased.

[0039]

Steps after that are the same as the well-known semiconductor device manufacturing method. That is, a semiconductor device is completed through packaging steps such as a step of picking up each semiconductor chip, a step of mounting the chip on a lead frame or TAB tape, and a step of encapsulating the chip in a package.

[0040]

FIG. 4 is a graph, in which the conventional manufacturing method and manufacturing apparatus are compared with the semiconductor device manufacturing methods according to the first and second embodiments of the present invention, and which shows the relationship between the chip bending strength [MPa] and the percent defective [%]. Symbols ◆, □, and △ plot the chip bending strength [MPa] as a function of the percent defective [%] of the conventional manufacturing method, that of the manufacturing method according to the second embodiment of the present invention, and that of the manufacturing method according to the first embodiment of the present invention, respectively.

[0041]

In the semiconductor device manufacturing method according to the first embodiment of the present invention, the bending strength greatly rises, and the percent defective decreases accordingly. In the semiconductor device manufacturing method according to the second embodiment, the bending strength decreases because the chips are thin. Nevertheless, this

bending strength is still higher than that of the conventional manufacturing method, and the percent defective is lower than that of the conventional manufacturing method. Accordingly, it is possible to eliminate defective products resulting from cracking of the semiconductor chips in the assembly steps (the pickup step and resin encapsulation step) or in the reliability test before the semiconductor chips are packaged.

[0042]

Incidentally, in the second embodiment, the surface processing is performed by laser beam irradiation before the back surface grinding step is performed. However, the laser beam irradiation may be performed after the back surface grinding step is performed.

[0043]

Furthermore, the present invention is not limited to the first and second embodiments described above, and the present invention can variously be modified.

[0044]

[Modification Example 1]

A processing bath for accommodating a semiconductor wafer in water is prepared, and laser beam irradiation is performed underwater, whereby temperature control becomes easy, and a rise in temperature of the chip caused by the laser beam irradiation can be suppressed.

[0045]

[Modification Example 2]

A vacuum chamber for accommodating a semiconductor wafer is prepared, and laser beam irradiation is performed in

a vacuum, whereby it is possible to suppress easy adhesion of the vaporized material resulting from the laser beam irradiation, and reduce contamination of the semiconductor chips.

[0046]

[Modification Example 3]

In the first and second embodiments, description is made by taking the case where the dicing step and laser beam irradiation step are separate steps as an example. However, as shown in FIG. 5, a diamond blade 23 and laser emitting apparatus 27 are fixed to a jig 29 in advance such that the dicing direction of the diamond blade 23 and the center of the irradiation position of a laser beam 28 emitted from the laser emitting apparatus 27 are aligned with each other. With this arrangement, the surface processing by laser beam irradiation can be successively performed subsequently to the dicing without adjusting the alignment of the dicing region 26 with the irradiation position of the laser beam 28.

[0047]

This modification example shown in FIG. 5 can be applied to both the first embodiment in which a semiconductor wafer is fully cut and the second embodiment in which a semiconductor wafer is half-cut.

[0048]

The present invention has been described above by using the first and second embodiments and modification examples 1 to 3. However, the present invention is not limited to these embodiments and their modification examples. The present

invention can be variously modified in the implementation stage within the range not deviating from the gist of the invention. Further, inventions of various stages are included in the embodiments described above, and by appropriately combining a plurality of disclosed configuration conditions with each other, various inventions can be extracted. For example, even if any constituent conditions are deleted from the entire constituent conditions, as long as at least one of the objects described in the paragraph of "Objects of the Invention" can be achieved and at least one of the advantages described in the paragraph of "Advantages of the Invention" can be obtained, the constituent conditions obtained after deletion of some conditions can be extracted as an invention.

[0049]

[Advantages of the Invention]

As has been described above, according to the present invention, it is possible to obtain a semiconductor device manufacturing method capable of suppressing a decrease in chip bending strength, and preventing cracking of semiconductor chips in the assembly steps or in the reliability test.

[0050]

It is also possible to obtain a semiconductor device manufacturing apparatus capable of suppressing a decrease in chip bending strength caused by dicing.

[Brief Description of the Drawings]

[FIG. 1]

FIG. 1 is a perspective view showing a dicing step, and for explaining a semiconductor device manufacturing method and

semiconductor device manufacturing apparatus according to a first embodiment of the present invention.

[FIG. 2]

FIG. 2 is a perspective view showing a step of processing the side surfaces of chips by laser beam irradiation, and for explaining the semiconductor device manufacturing method and semiconductor device manufacturing apparatus according to the first embodiment of the present invention.

[FIG. 3]

FIG. 3 shows microphotographs for comparing the side surfaces of semiconductor chips formed by the semiconductor device manufacturing methods and semiconductor device manufacturing apparatuses according to the prior art and the first embodiment of the present invention.

[FIG. 4]

FIG. 4 is a graph showing the relationship between the chip bending strength and the percent defective by comparing semiconductor chips formed by the semiconductor device manufacturing methods and semiconductor device manufacturing apparatuses according to the prior art and the first and second embodiments of the present invention with each other.

[FIG. 5]

FIG. 5 is a perspective view for explaining a modification example of the semiconductor device manufacturing methods and semiconductor device manufacturing apparatuses according to the first and second embodiments of the present invention.

[FIG. 6]

FIG. 6 shows perspective views, showing a dicing step and

dicing apparatus for forming individual semiconductor chips by dividing a semiconductor wafer, and for explaining a conventional semiconductor device manufacturing method and semiconductor device manufacturing apparatus.

[Explanation of Reference Symbols]

21 ··· Semiconductor wafer,

22 ··· Adhesive sheet,

23 ··· Diamond blade,

24 ··· Dicing line,

25-1, 25-2, 25-3 ··· Semiconductor chip,

26 ··· Dicing region,

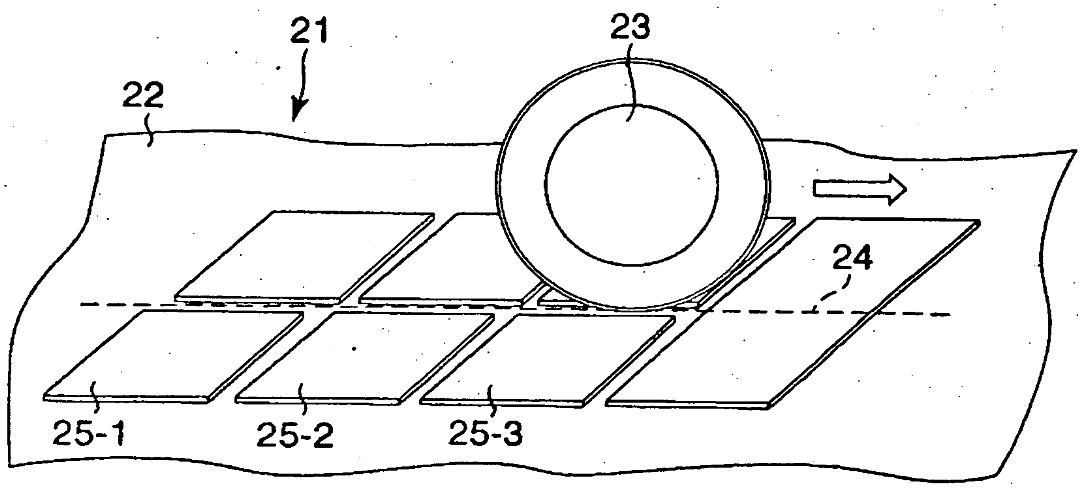
27 ··· Laser emitting apparatus,

28 ··· Laser beam, and

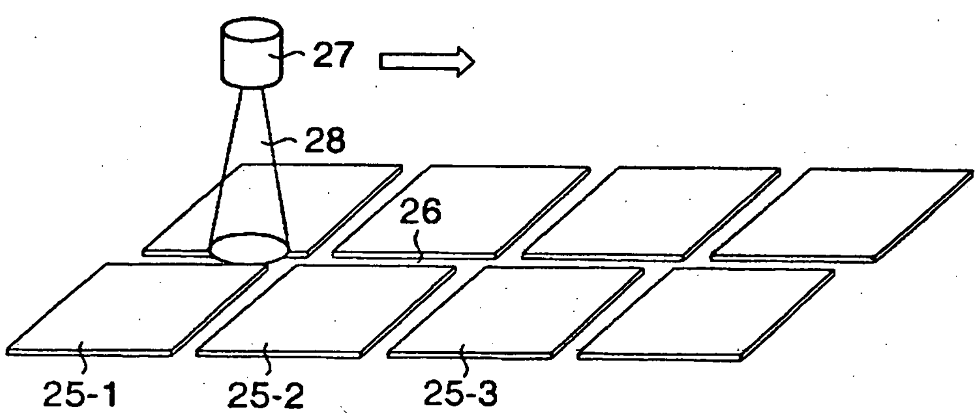
29 ··· Jig.

【書類名】　図面
[NAME OF DOCUMENT] DRAWINGS

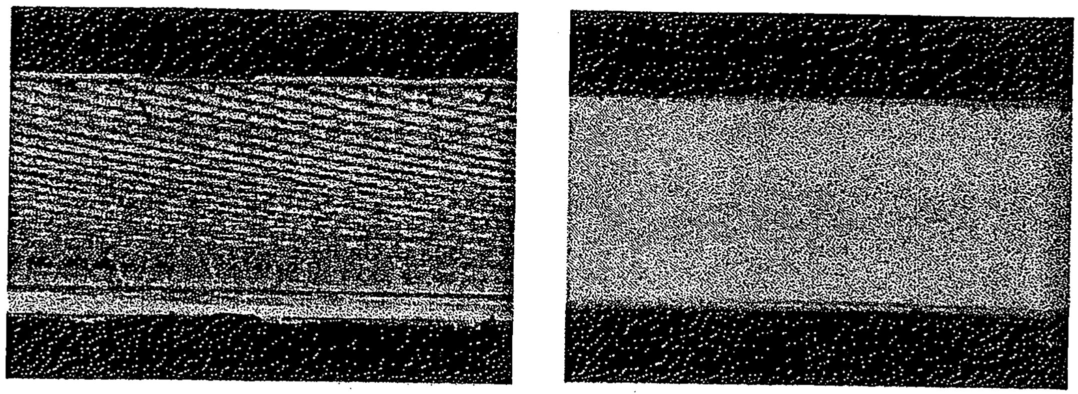
【図１】
[FIG. 1]



【図２】
[FIG. 2]

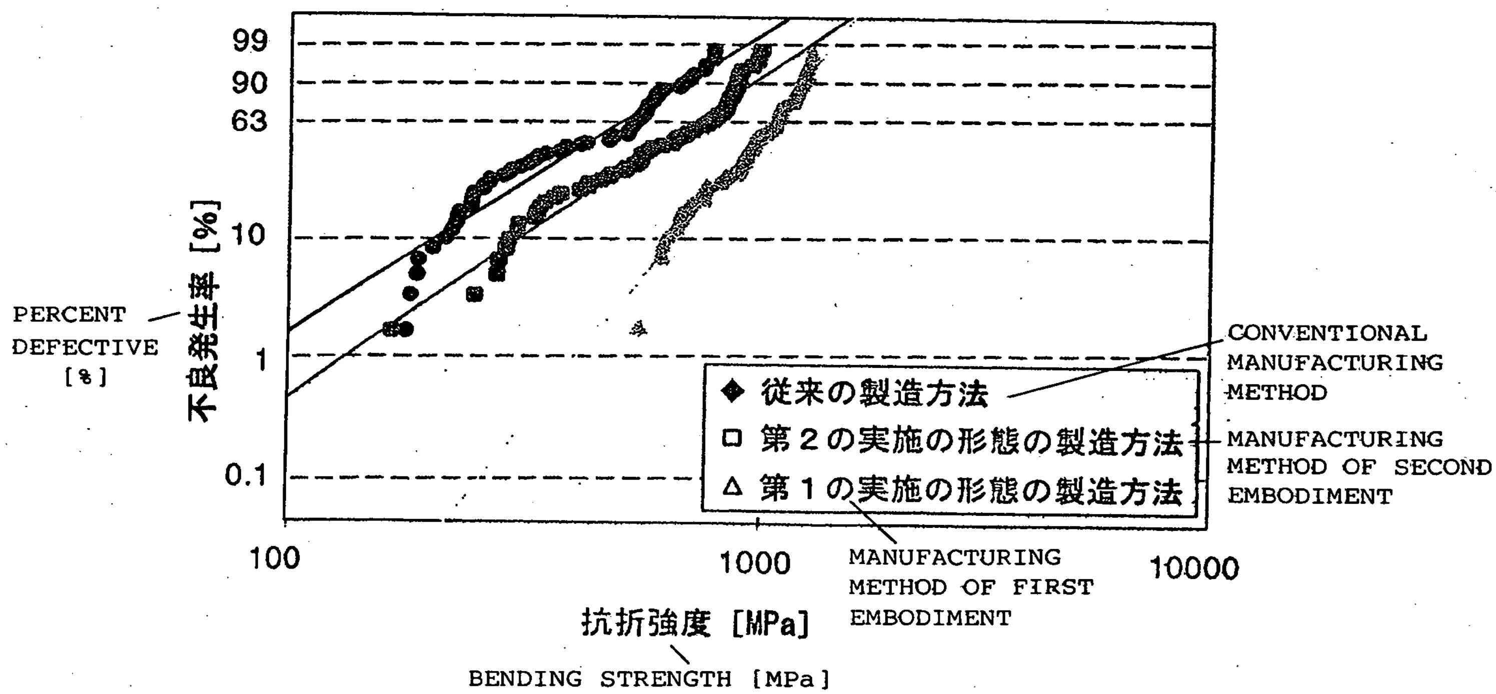


【図３】
[FIG. 3]

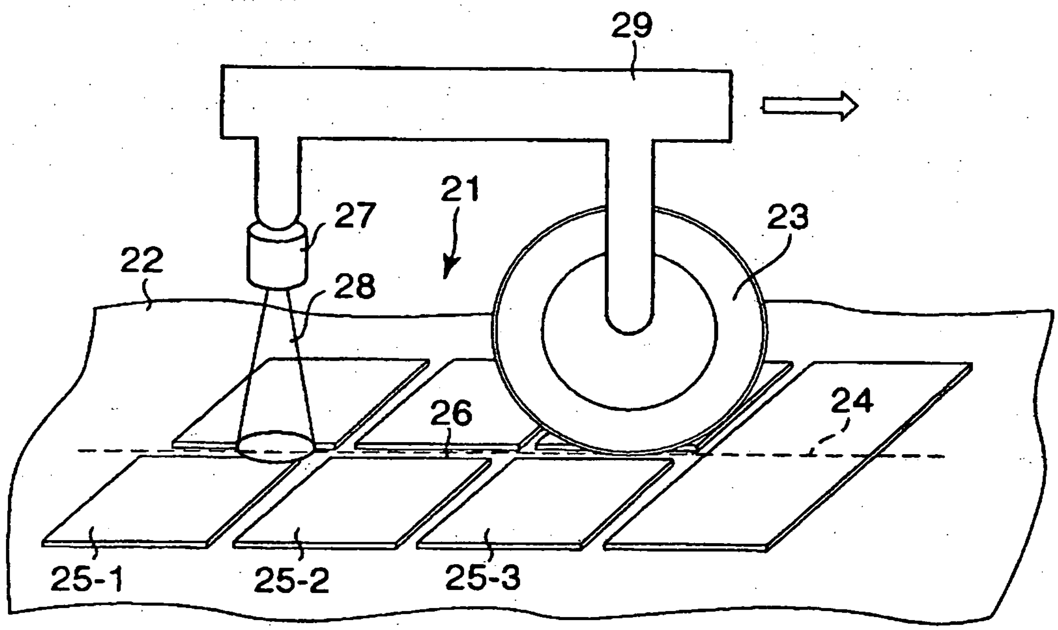


(a) (b)

【図４】
[FIG. 4]



【図５】
[FIG. 5]

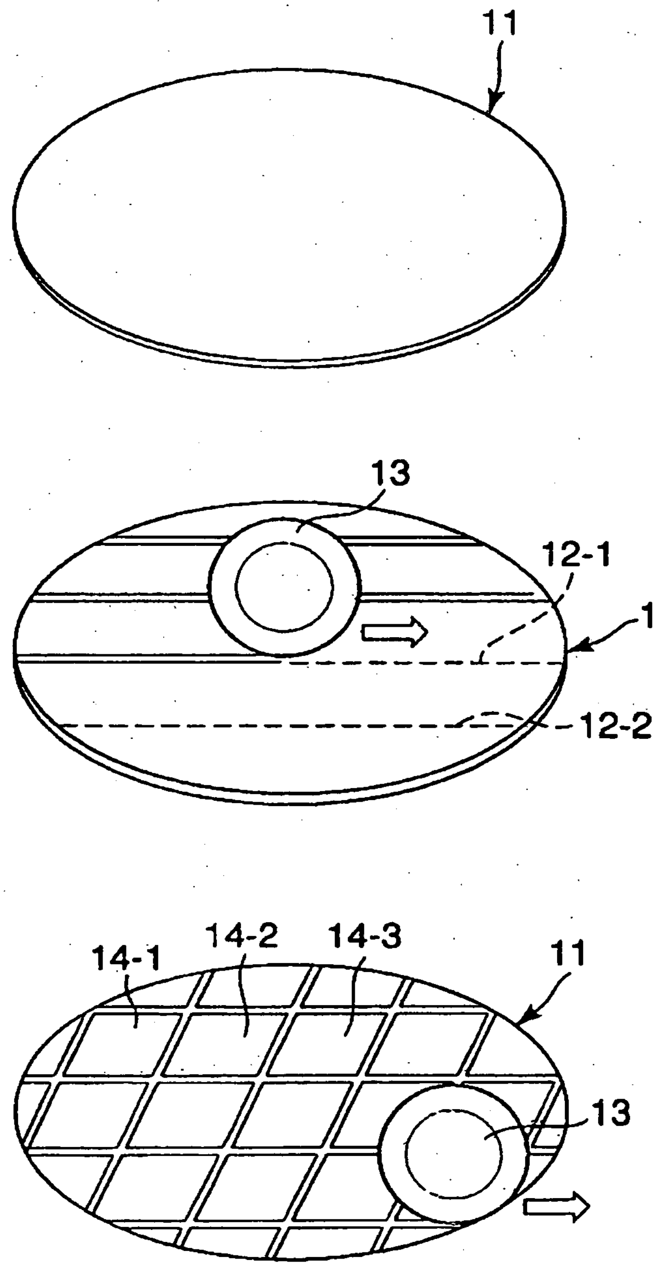


【図6】
[FIG. 6]

(a)

(b)

(c)



[Document] ABSTRACT

[Abstract]

[Object] An object of the present invention is to provide a semiconductor device manufacturing method capable of suppressing a decrease in chip bending strength, and preventing cracking of semiconductor chips in the assembly steps or in the reliability test.

[Means for Achieving the Object] A semiconductor device manufacturing method is characterized by comprising: a step of forming a semiconductor element in a semiconductor wafer (21); a step of performing dicing on the semiconductor wafer (21) along a dicing line (24); and a step of thereafter irradiating a dicing region (26) of the semiconductor wafer with a laser beam (28) to melt or vaporize a cutting streak formed by dicing. After the dicing step for dividing the semiconductor wafer into individual chips is performed, an upper and side surfaces of semiconductor chips 25-1, 25-2, 25-3, ⋯, are irradiated with the laser beam, whereby strain or chipping caused by cutting streaks is removed by melting or evaporating the cut surface. Accordingly, bending strength of the semiconductor chip can be enhanced.

[Elected Figure] FIG. 2